PB-243 905

LOST LAKE, ST. LOUIS COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
National Environmental Research Center
Minnesota Pollution Control Agency
Minnesota National Guard

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NATIONAL EUTROPHICATION SURVEY

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT
ON
LOST LAKE
ST. LOUIS COUNTY
MINNESOTA

EPA REGION V

WORKING PAPER NO. 143

WITH THE COOPERATION OF THE

MINNESOTA POLLUTION CONTROL AGENCY

AND THE

MINNESOTA NATIONAL GUARD

JULY, 1975

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F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

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* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries were not sampled, and this report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

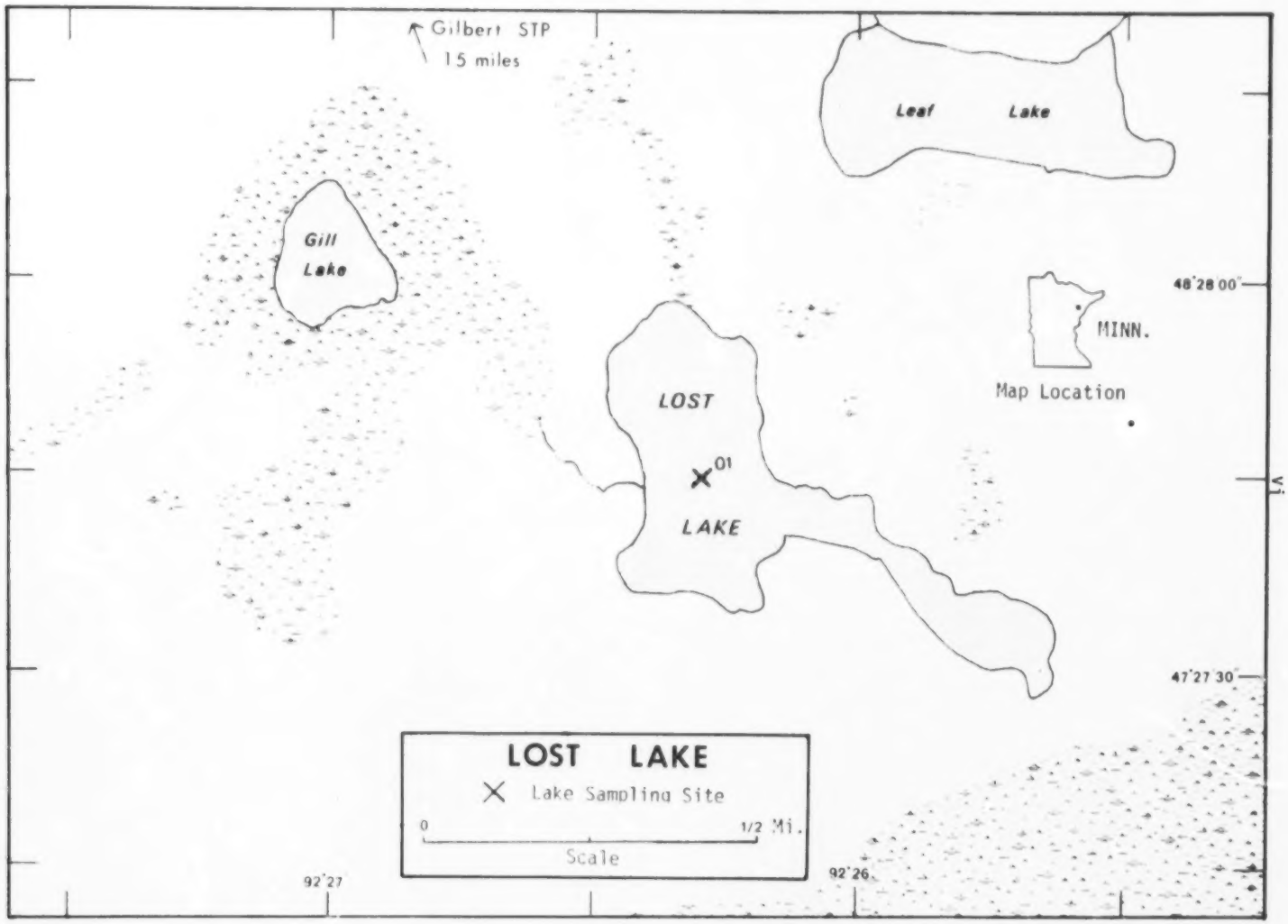
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


Gilbert STP
15 miles
Leaf Lake
Gill Lake
48°28'00"
MINN.
Map Location
LOST
01
LAKE
47°27'30"
LOST LAKE
Lake Sampling Site
0
1/2 Mi.
Scale
92°27
92°26

LOST LAKE

STORET NO. 27B8

I. INTRODUCTION

Lost Lake was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Wastewater treatment plant samples were provided by the City of Gilbert (Appendix B); however, tributaries were not sampled, and other nutrient sources were not evaluated. Therefore, this report primarily relates to the lake sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data show Lost Lake is hypereutrophic. Of the 60 Minnesota lakes sampled in the fall when essentially all were well-mixed, 51 had less mean total phosphorus, 40 had less mean dissolved phosphorus, and 36 had less mean inorganic nitrogen. Of the 80 Minnesota lakes sampled, 75 had less mean chlorophyll a, and 49 had greater mean Secchi disc transparency. Dissolved oxygen was markedly depleted at four feet in September, 1972.

Survey limnologists observed algal blooms in progress in September and October.

B. Rate-Limiting Nutrient:

The algal assay results show Lost Lake was nitrogen limited at the time the sample was taken (10/19/72). The lake data indicate nitrogen limitation at the other sampling times as well.

C. Point-Source Nutrient Contribution:

Based on analyses of effluent samples from the trickling filter plant serving the City of Gilbert*, this point source contributed 5,380 pounds of total phosphorus and 23,680 pounds of total nitrogen via a ditch to Lost Lake during the Survey sampling year.

* Anonymous, 1974.

III. LAKE CHARACTERISTICS

A. Lake Morphometry*:

1. Surface area: 77 acres.
2. Mean depth: 9.9 feet.
3. Maximum depth: 18 feet.
4. Volume: 762 acre-feet.

B. Precipitation**:

1. Year of sampling: 28.0 inches.
2. Mean annual: 26.9 inches.

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* MN Dept. of Conservation lake survey map (1968); mean depth by random-dot method.

** See Working Paper No. 1, "Survey Methods, 1972".

IV. LAKE WATER QUALITY SUMMARY

Lost Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two or more depths at a single station on the lake (see map, page vi). During each visit, a single depth-integrated (near bottom to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was collected for chlorophyll a analysis. During the last visit, a single five-gallon depth-integrated sample was taken for algal assays. The maximum depth sampled was 9 feet.

The results obtained are presented in full in Appendix A, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized in the following table. Note, however the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix A.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/19/72)		
Temperature (Cent.)	4.2	4.3	4.3	4.4
Dissolved oxygen (mg/l)	12.4	13.0	13.0	13.6
Conductivity (μmhos)	220	228	230	233
pH (units)	9.6	9.6	9.6	9.6
Alkalinity (mg/l)	73	75	76	76
Total P (mg/l)	0.328	0.340	0.346	0.346
Dissolved P (mg/l)	0.086	0.089	0.090	0.091
NO_2 + NO_3 (mg/l)	0.190	0.197	0.200	0.200
Ammonia (mg/l)	0.100	0.103	0.100	0.110
		ALL VALUES		
Secchi disc (inches)	18	33	33	48

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/08/72	1. Anabaena	1,450
	2. Dinobryon	1,390
	3. Mallomonas	1,057
	4. Gloeocapsa	876
	5. Cryptomonas	665
	Other genera	1,329
	Total	6,767
09/09/72	1. Lyngbya	23,840
	2. Microcystis	5,906
	3. Anabaena	4,239
	4. Merismopedia	1,413
	5. Scenedesmus	652
	Other genera	1,595
	Total	37,645
10/19/72	1. Cyclotella	81,060
	2. Dictyosphaerium	15,152
	3. Scenedesmus	8,333
	4. Micractinium	6,667
	5. Actinastrum	5,606
	Other genera	14,243
	Total	131,061

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/08/72	01	21.8
09/09/72	01	20.1
10/19/72	01	388.7

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.105	0.485	17.7
0.006 P	0.111	0.485	17.6
0.012 P	0.117	0.485	14.4
0.024 P	0.129	0.485	16.8
0.060 P	0.165	0.485	16.7
0.060 P + 10.0 N	0.165	10.485	52.2
10.0 N	0.105	10.485	49.0

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Lost Lake was high at the time the sample was collected. Nitrogen was clearly the limiting nutrient in the algal assay sample. The combined spike of nitrogen and phosphorus stimulated growth only slightly more than the nitrogen spike alone. No growth response accompanied spikes of orthophosphorus alone.

The lake data indicate nitrogen limitation at the other sampling times as well; i.e., the N/P ratio was less than 1/1 in July and was 4/1 in September, and nitrogen limitation would be expected.

V. LITERATURE REVIEWED

Anonymous, 1974. Wastewater disposal facilities inventory. MPCA, Minneapolis.

VI. APPENDICES

APPENDIX A

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

27MN01
47 27 45.0 092 26 15.0
LOST LAKE
27 MINNESOTA

11EPALES
3

2111202
000A FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/09	15 00	0000	20.8	12.8	18	210	10.00	91	0.060	0.040	0.349	0.168
	15 00	0003	19.1	6.0		210	9.20	90	0.040	0.120	0.313	0.240
72/09/09	11 05	0000			48	240	8.70	99	0.130	1.880	0.660	0.506
	11 05	0004	15.7	2.7		239	8.78	97	0.150	1.820	0.685	0.503
72/10/19	15 35	0000				220	9.60	73	0.190	0.100	0.346	0.091
	15 35	0004	4.2	12.4		230	9.60	76	0.200	0.100	0.328	0.086
	15 35	0009	4.4	13.6		233	9.60	76	0.200	0.110	0.346	0.090

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/09	15 00	0000	21.8J
72/09/09	11 05	0000	20.1J
72/10/19	15 35	0000	398.7J

J VALUE KNOWN TO BE IN ERROR

APPENDIX B

SEWAGE TREATMENT PLANT DATA

STORET RETRIEVAL DATE 74/10/30

27HA51 TF27HA51 P002287
47 29 30.0 092 29 30.0
GILBERT
27 7.5 GILBERT
D/LOST (MORSESHOE)
LOST LAKE
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/02/01	11 00								
CP(T)- 73/02/01	13 00		0.620	15.000	7.350	2.700	3.600	0.395	0.400
73/03/01	11 00								
CP(T)- 73/03/01	13 00		0.315	16.000	7.900	3.000	3.800	0.385	0.400
73/04/02	11 00								
CP(T)- 73/04/02	13 00		0.450	13.000	5.300	2.750	3.700	0.380	0.400
73/04/23	11 00								
CP(T)- 73/04/23	13 00		1.580	23.600	14.200	3.800	4.550	0.385	0.400
73/05/01	11 00								
CP(T)- 73/05/01	13 00		0.540	15.400	3.700	2.550	3.600	0.300	0.400
73/06/01	11 00								
CP(T)- 73/06/01	13 00		0.515	16.000	4.730	2.650	3.800	0.385	0.400
73/07/02	11 00								
CP(T)- 73/07/02	13 00		0.500	12.600	3.500	3.500	4.700	0.278	0.400
73/08/01	11 00								
CP(T)- 73/08/01	13 00		2.900	37.000	1.320	2.050	3.525	0.395	0.400
73/09/01	11 00								
CP(T)- 73/09/01	13 00			17.400	6.400	3.310	5.100	0.325	0.400
73/10/01	11 00								
CP(T)- 73/10/01	13 00		1.000	14.400	7.550	3.300	5.400	0.385	0.400
73/11/01	11 00								
CP(T)- 73/11/01	13 00		1.050	22.000	4.300	3.300	6.600	0.375	0.400
73/12/01	11 00								
CP(T)- 73/12/01	13 00		1.500	17.500	4.800	2.900	4.800	0.345	0.400

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STORET RETRIEVAL DATE 74/10/10

27HR51 TF27HR51 P0022H7
47 29 30.0 092 29 30.0
GILBERT
27 7.5 GILBERT
D/LOST (HORSESHOE)
LOST LAKE
11FPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00625 NITROGEN,NO3+NO2-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/01/02	11 00								
CP(T)-			1.[illegible]	14.500	5.[illegible]20	3.100	4.300	0.385	0.400
74/01/02	13 00								